WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2002IA25G

Title: An Integrated Immunological-GIS Approach for Bio-monitoring of Ecological Impacts of Swine Manure Pollutants in Streams

Projects Type: Research

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Keywords: water quality, fish, immunology, GIS, swine manure, non-point source pollution

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Abstract

Thirty years after enactment of the Clean Water Act, 40% of our nation's rivers, lakes, and coastal waters are still considered unfit for fishing, swimming, drinking or aquatic life. At least 10 % of the nation's impaired river miles are affected by pollution from livestock operations. Because of its volume, composition, and handling methods, swine fecal material is a serious threat to environmental quality in regional waterways and especially in Iowa. From 1995 to 1998, for example, over 13 million fish were killed in more than two hundred documented manure spills in the Midwest. Local citizens are becoming increasingly intolerant of the environmental cost of confinement livestock production. Although catastrophic pollution events attract the most attention, exposure of aquatic organisms to sub lethal pollutant concentrations can also have significant ecological impact by interfering with normal life processes such as feeding, reproduction, defense and disease resistance. This can result in gradual declines and even extirpations of animal populations and communities. Such chronic effects of manure pollution are poorly known, because of the difficulty of measuring them and placing them in ecological context. We suggest that innate immune response in fish can provide a tool for determining chronic and sub lethal impacts of manure on aquatic animals. The hypothesis is that low levels of swine liquid manure slurry and anaerobic lagoon liquid released to open water cause changes in immunological response in fish and increase fish susceptibility to infection. The first objectives of the project, therefore, are to evaluate this

hypothesis through a series of laboratory immunological assays applied to a native test organism, the fathead minnow, and to develop one or more assays for use as a bio-monitoring technique to detect ecological impact of manure pollution in nature. Subsequently, we will characterize a number of Iowa watersheds and stream systems according to their potential susceptibility to hog manure pollution and use this information to design a water quality and fish sampling regime in order to quantitatively measure ecological impact of manure pollution on the streams. We will compare this approach to more traditional chemical and biological pollution measurement techniques and evaluate its utility as a biomonitoring tool for environmental protection agencies.

The immune response of fathead minnows to swine manure will be determined by activity of phagocytic cells, through several forms of measurement. Evidence from limited research involving fish suggests that several respiratory burst activity (RBA) assays may be useful for determining phagocytic function, and the procedure also seems to hold promise as a bio-indicator for fish health. Additionally, histological examinations of melano-macrophage centers (MMC) in liver, spleen, kidneys, intestines, skin and gills will be used to measure effects of long term exposure to manure. The project will apply GIS technology and landscape modeling to calculate possible swine pollutant flow path patterns in Iowa watersheds having large hog confinements and in those where liquid manure fertilizer is applied on crop fields. Necessary data will be obtained from the Iowa Rivers Information System (IRIS) and Iowa Gap and Aquatic Gap databases that are maintained by the USGS BRD Iowa Cooperative Fish and Wildlife Research Unit. Using this approach, we will estimate temporal and spatial distribution of manure loads and concentrations that reach receiving waters from agricultural operations. This will provide the basis for a field sampling regime to determine actual conditions of water quality and fish communities at stream sites selected to represent a range of calculated manure pollutant loadings.